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Oh et al.

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(54) **EARPHONE DEVICE HAVING BIOLOGICAL INFORMATION MEASURING APPARATUS**

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(73) Assignee: **Samsung Electronics Co., Ltd** (KR)

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
H04R 25/00 (2006.01)

(52) **U.S. Cl.**
USPC **381/376**; 381/367; 381/370; 381/384; 600/309; 379/430

(58) **Field of Classification Search**
USPC 381/367, 376, 370, 384; 600/309; 379/430
See application file for complete search history.

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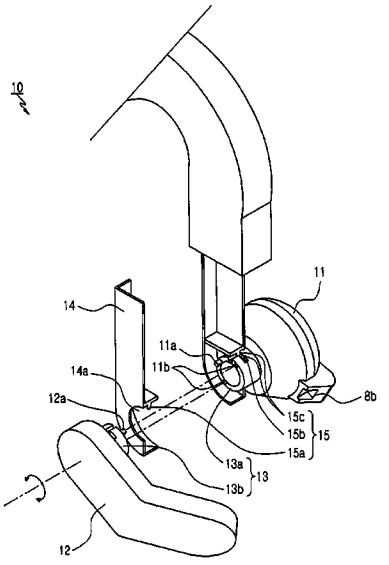
(57) **ABSTRACT**

An earphone device having a biological information measuring apparatus, structured to facilitate insertion into a user's ear or to absorb vibration generated by external movement before or after the insertion. To this end, the earphone device includes a speaker portion, a sensor housing rotatably coupled with the speaker portion, a shaft provided in the speaker portion and the sensor housing to couple the speaker portion with the sensor housing such that the speaker portion and the sensor housing rotate together, a support housing coupled with the shaft to pass the shaft therethrough, the support housing supporting rotation of the speaker portion and the sensor housing, and a stopper portion provided in the shaft and the support housing to rotate the speaker portion and the sensor housing and then stop them before or after insertion into a user's ear, thereby facilitating the insertion or urging the speaker portion to contact the user's ear.

16 Claims, 28 Drawing Sheets



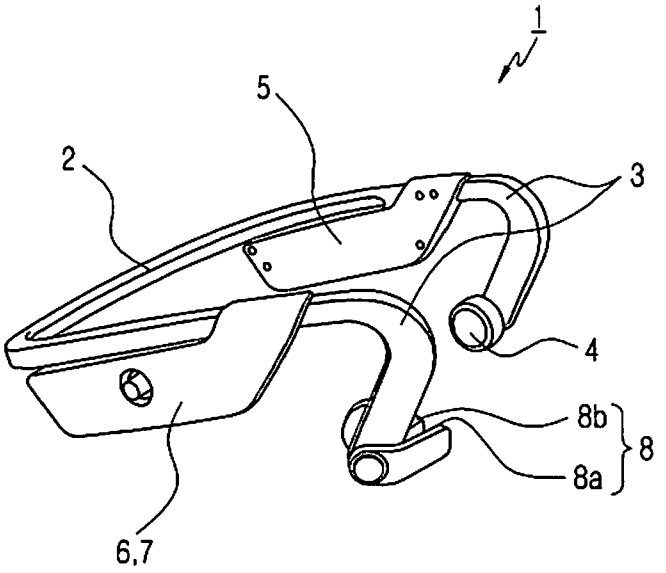


FIG.1
(PRIOR ART)

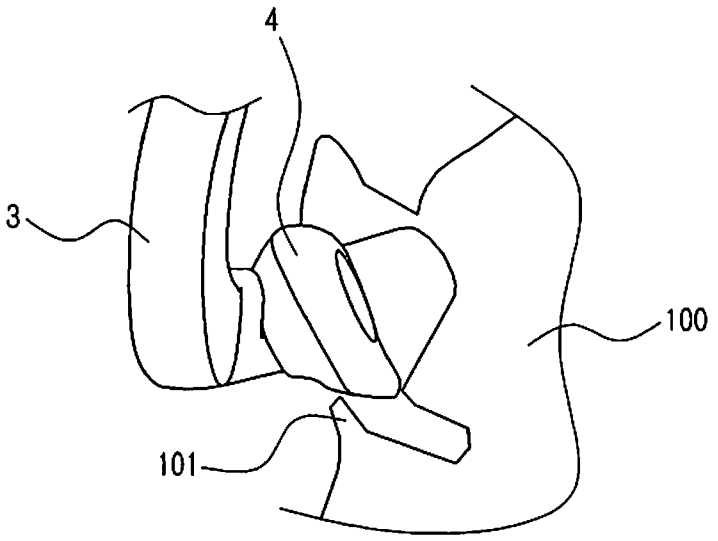


FIG.2
(PRIOR ART)

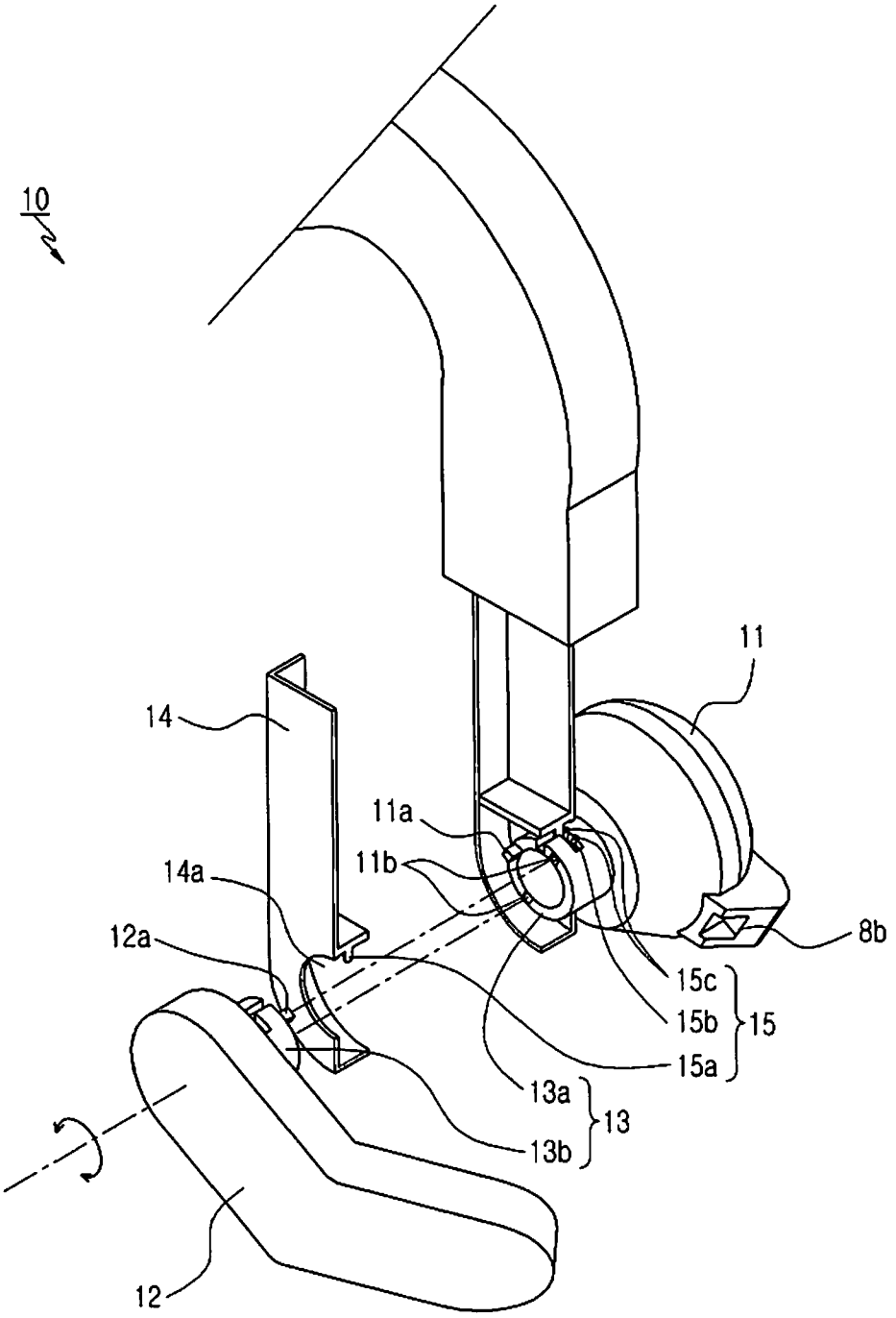


FIG.3

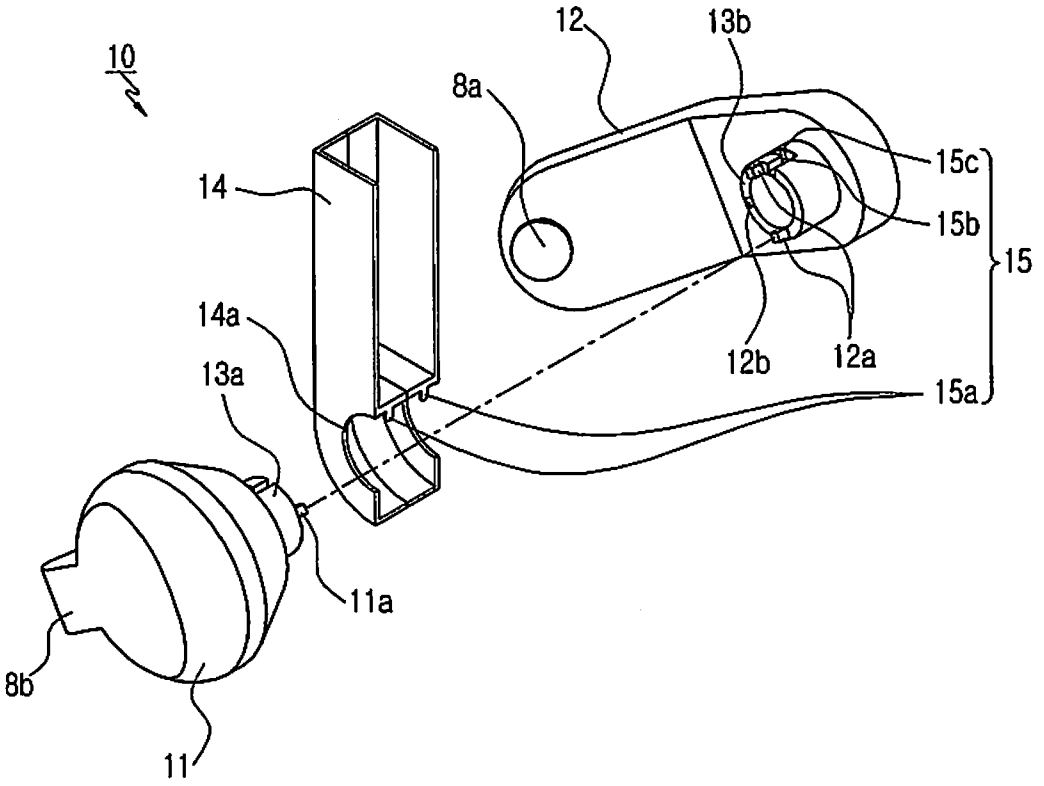


FIG.4

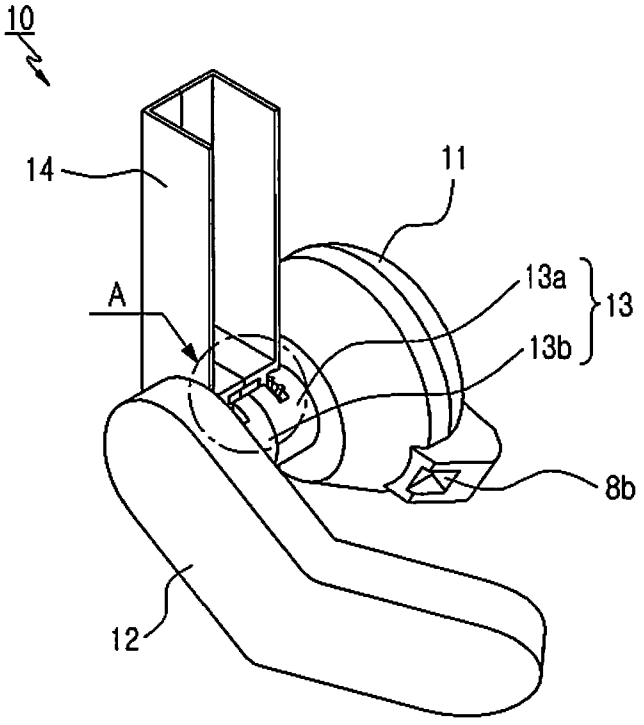


FIG.5

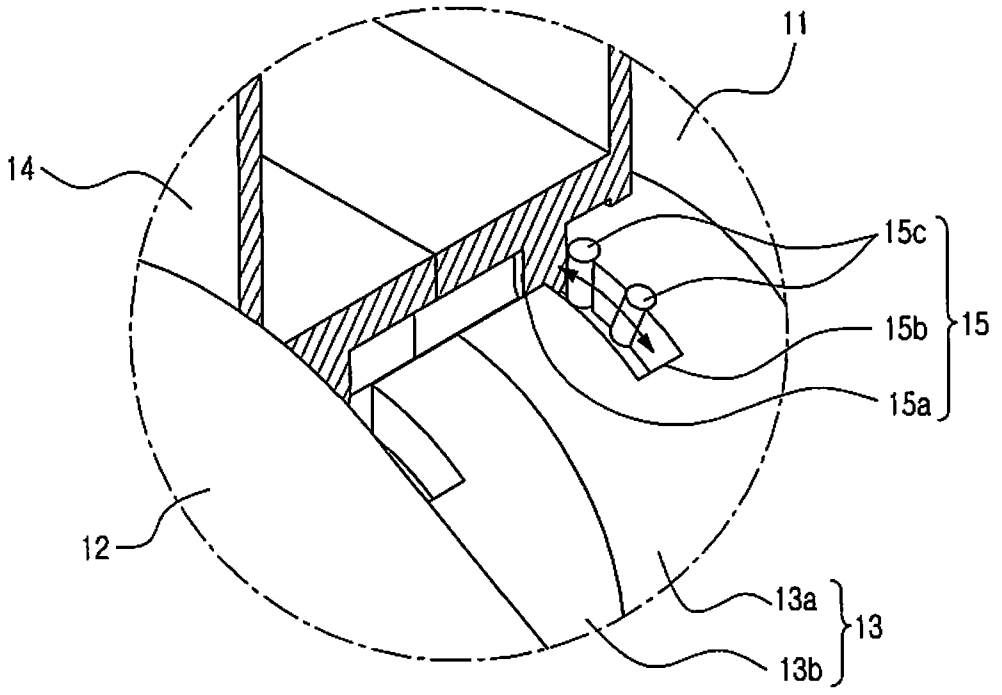


FIG.6

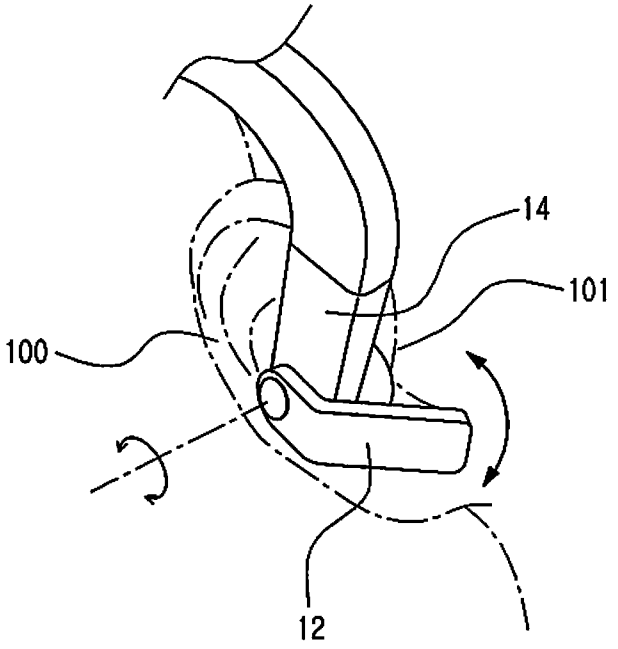


FIG.7

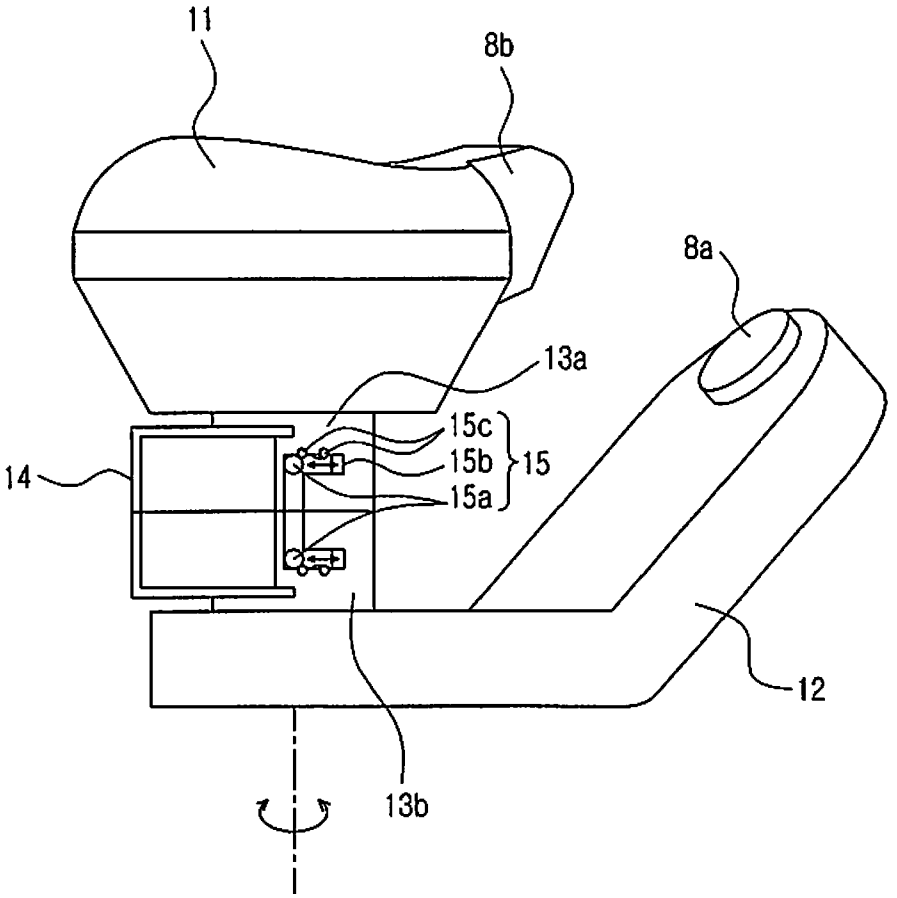


FIG.8

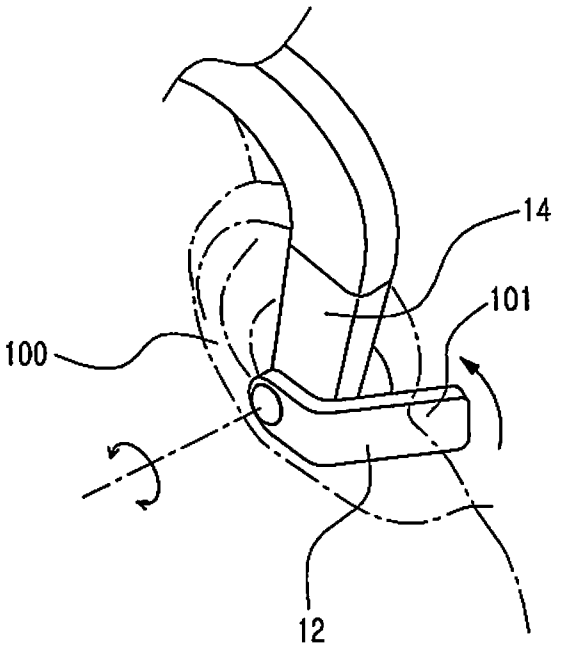


FIG.9

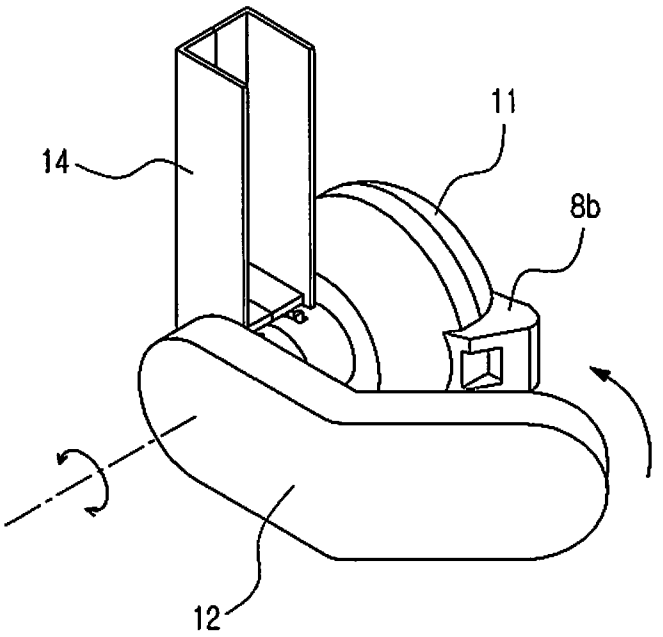
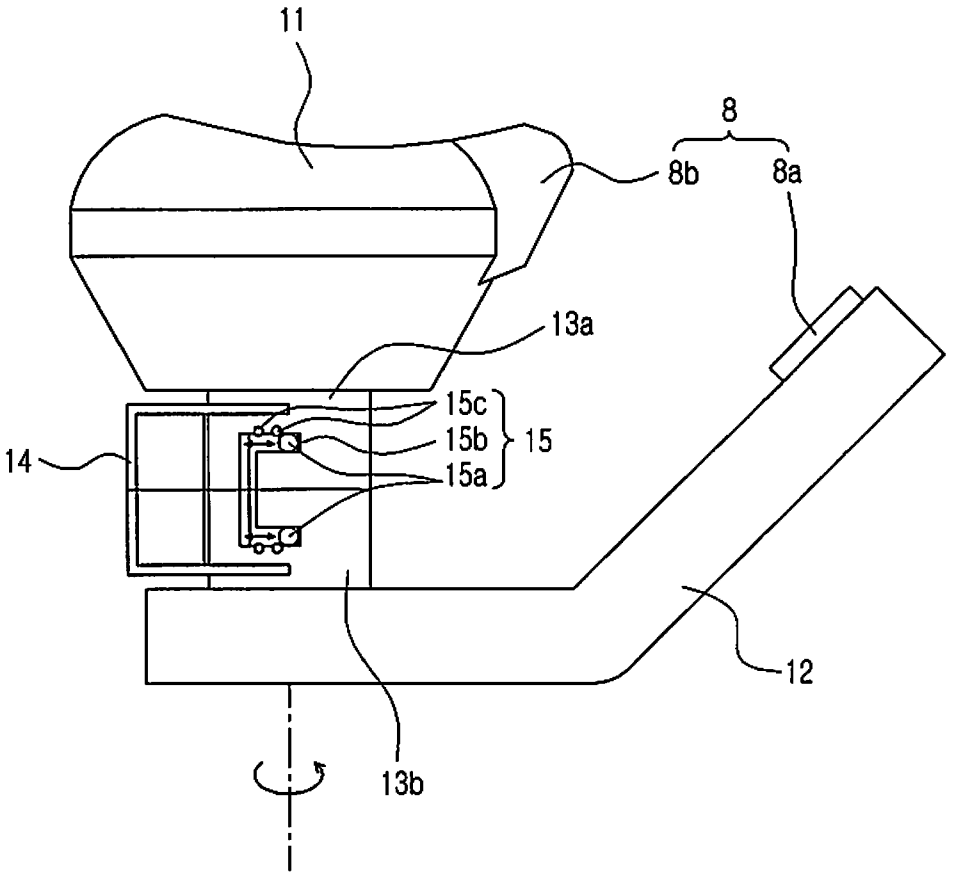


FIG.10



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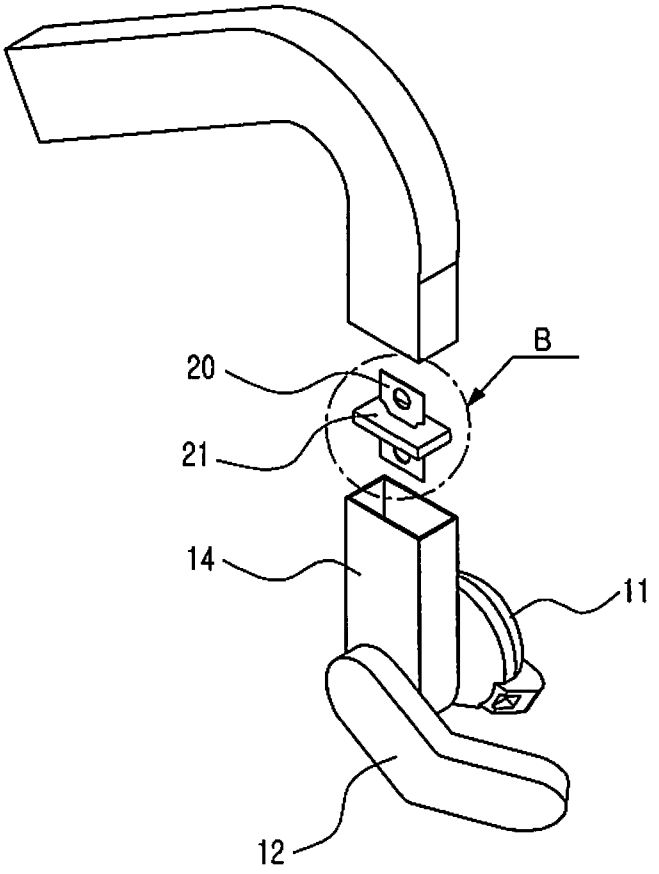


FIG.12

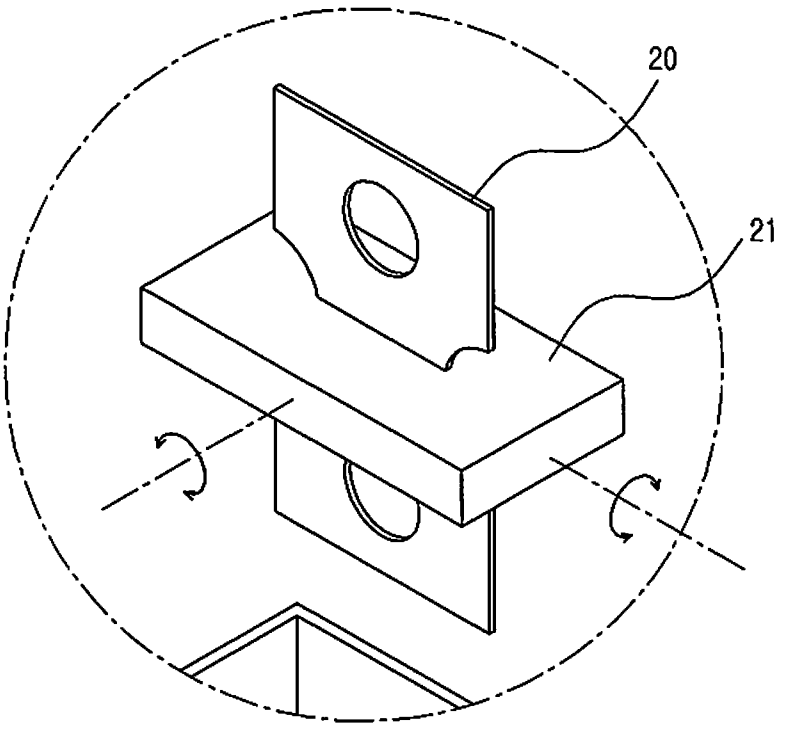
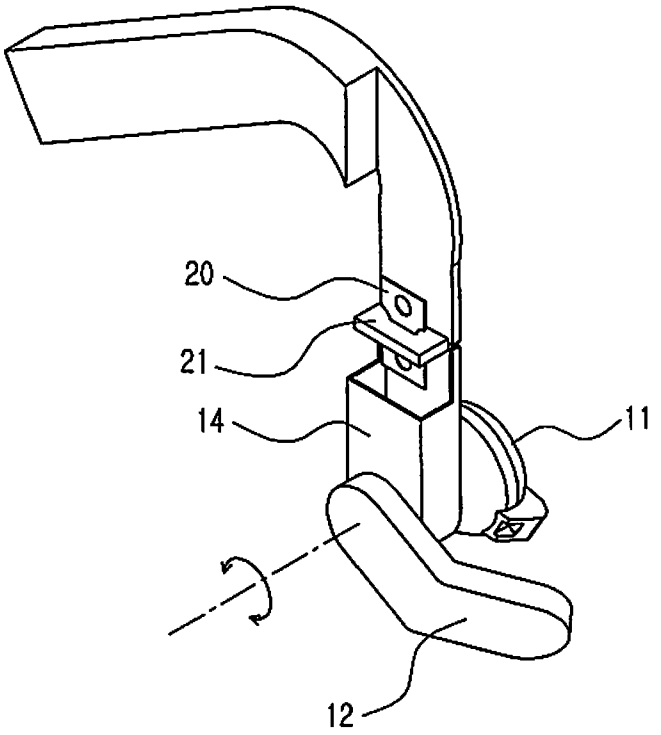


FIG.13



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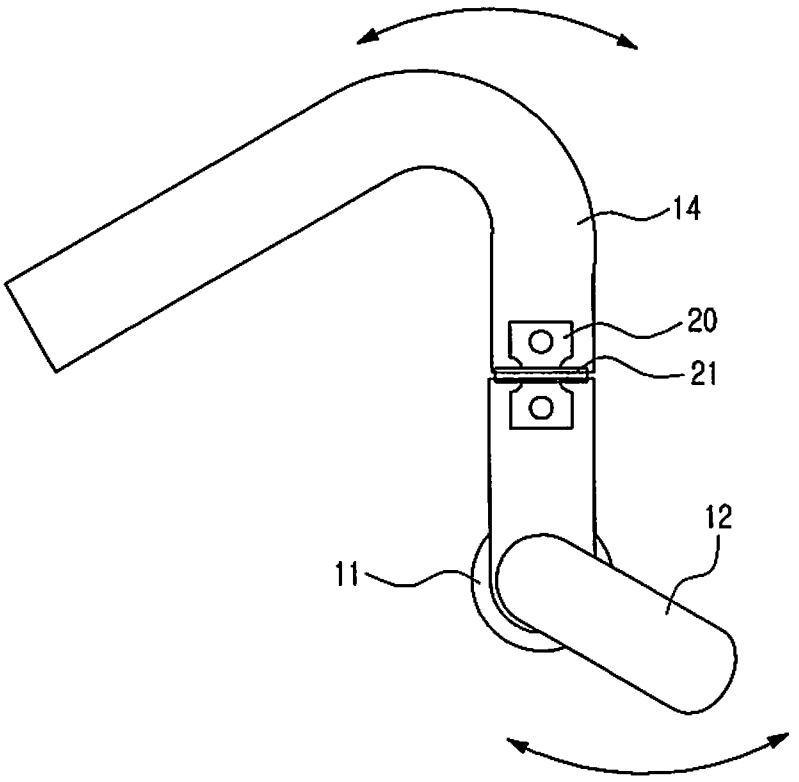
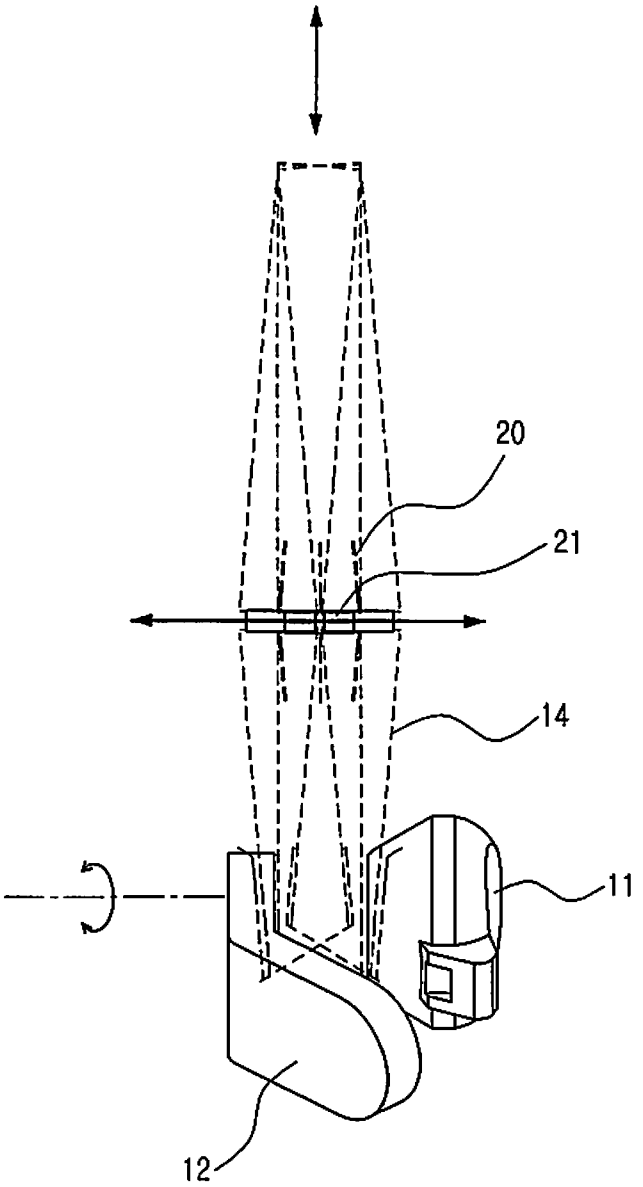


FIG.15



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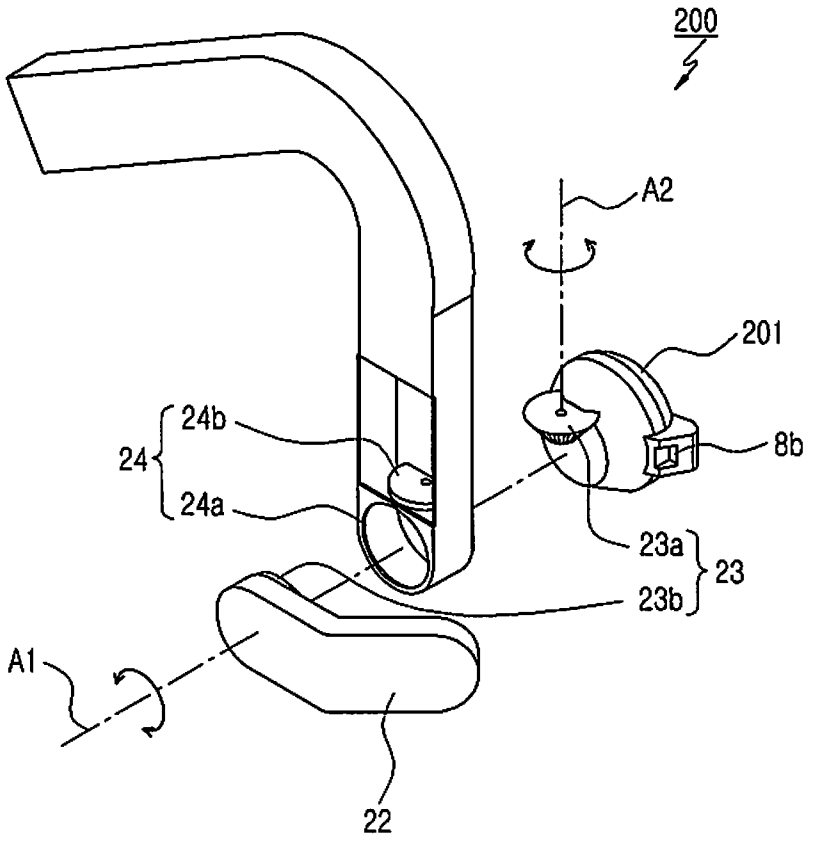

FIG.17

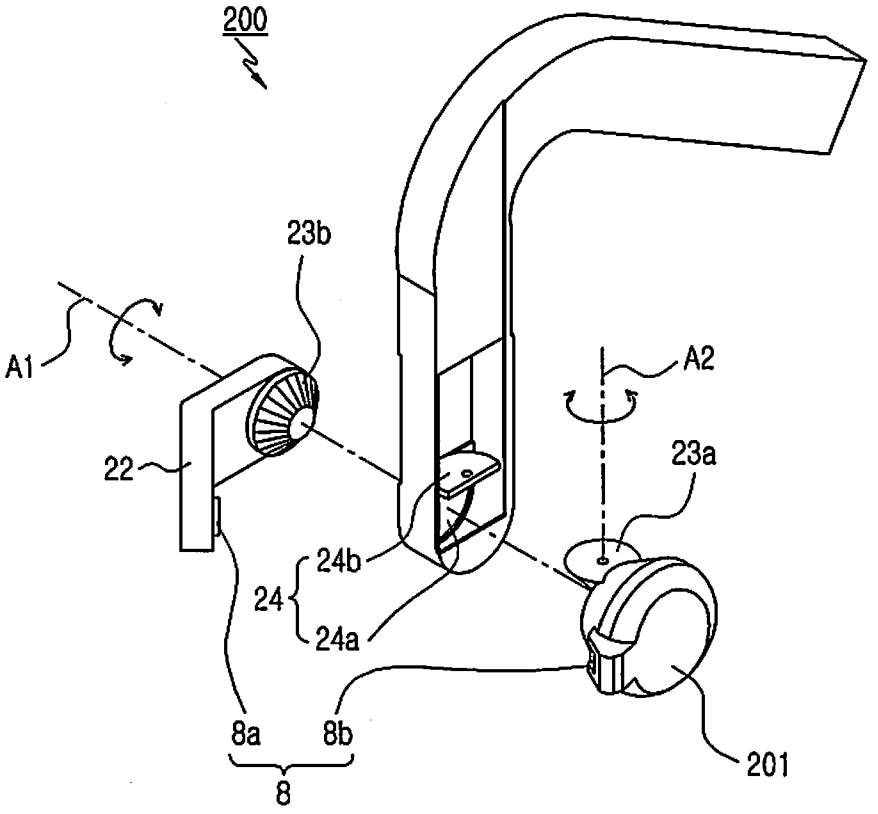

FIG.18

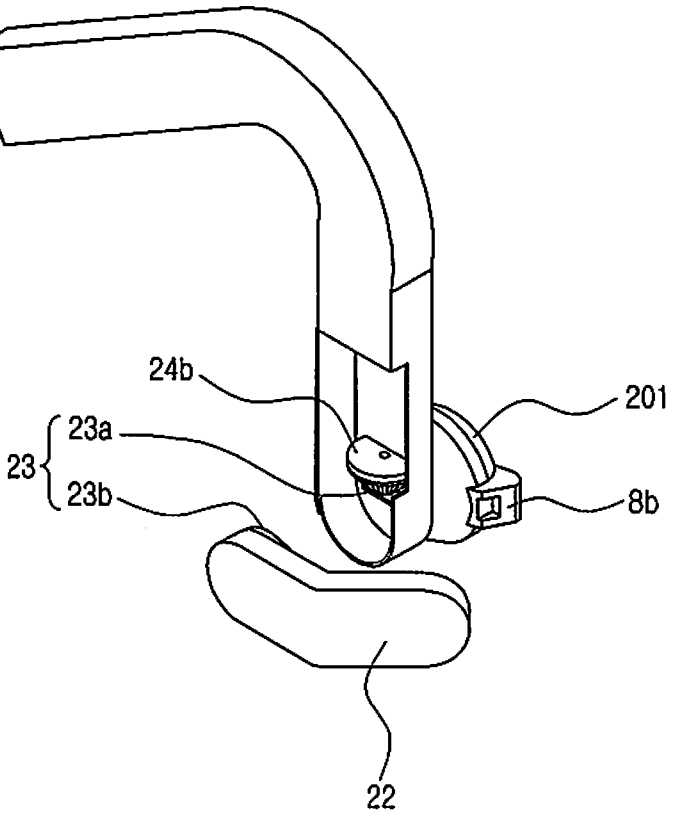

FIG.19

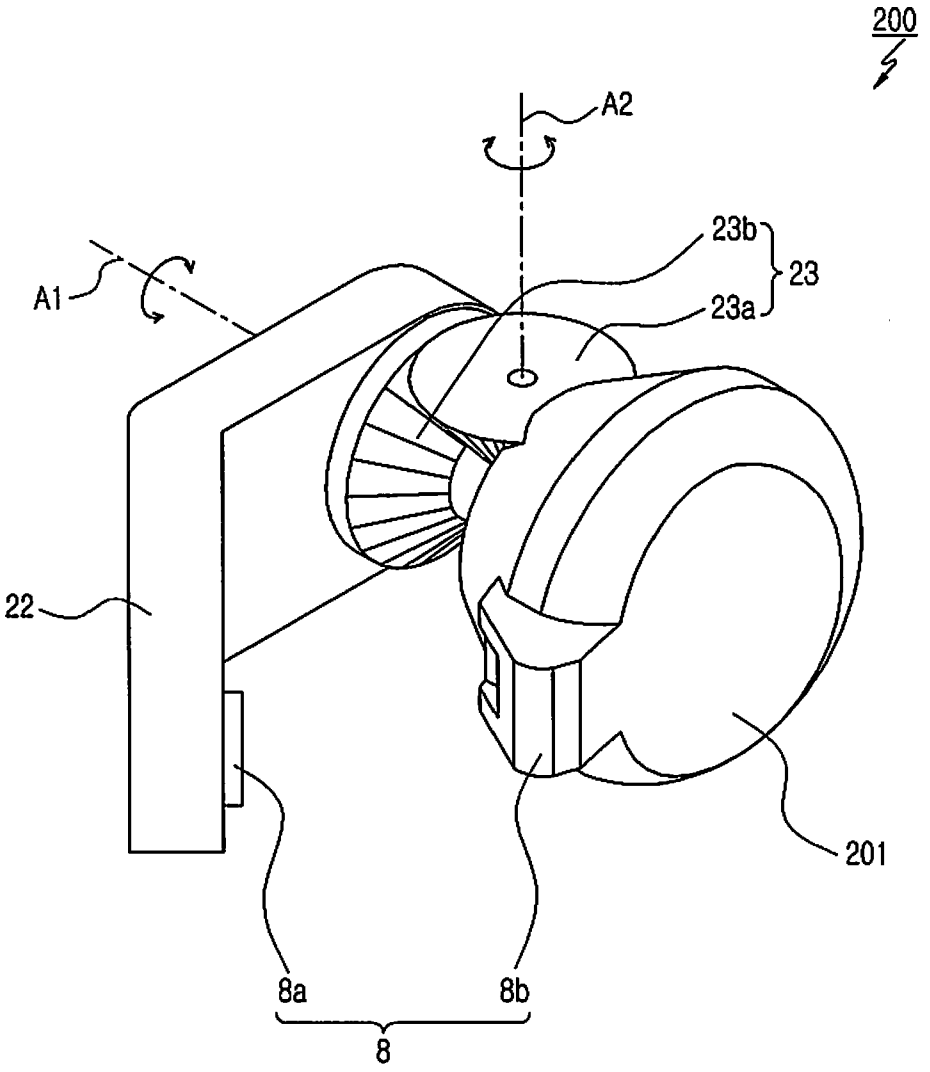

FIG.20

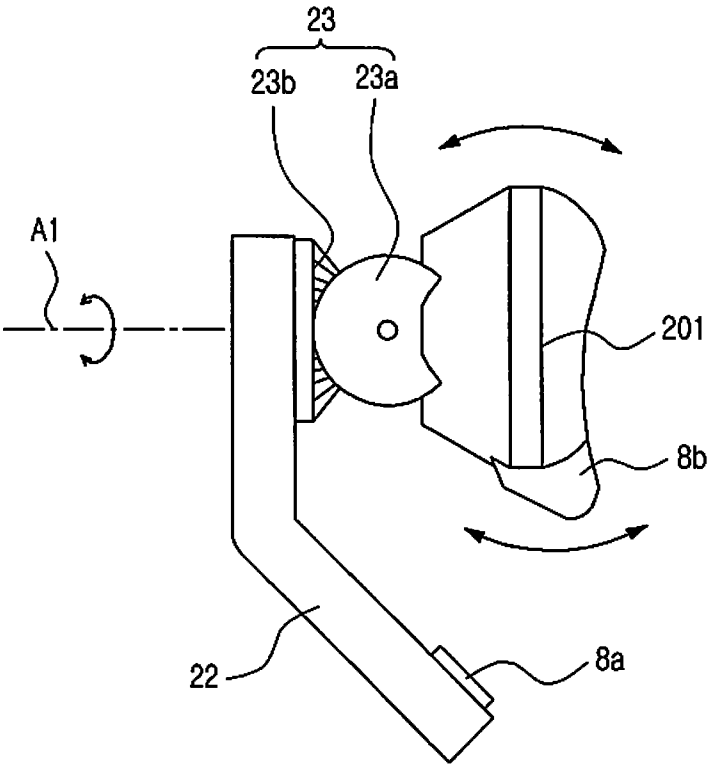

FIG.21

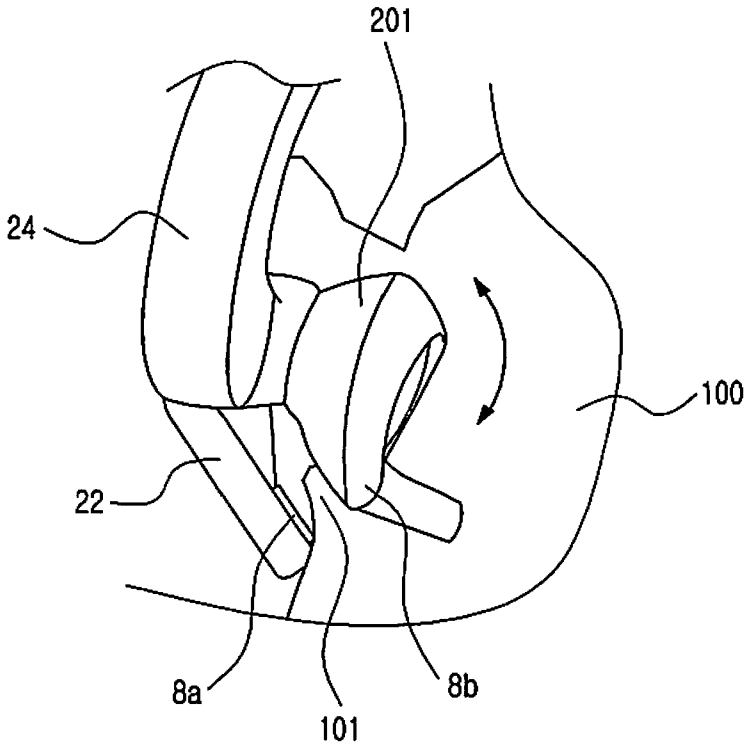

FIG.22

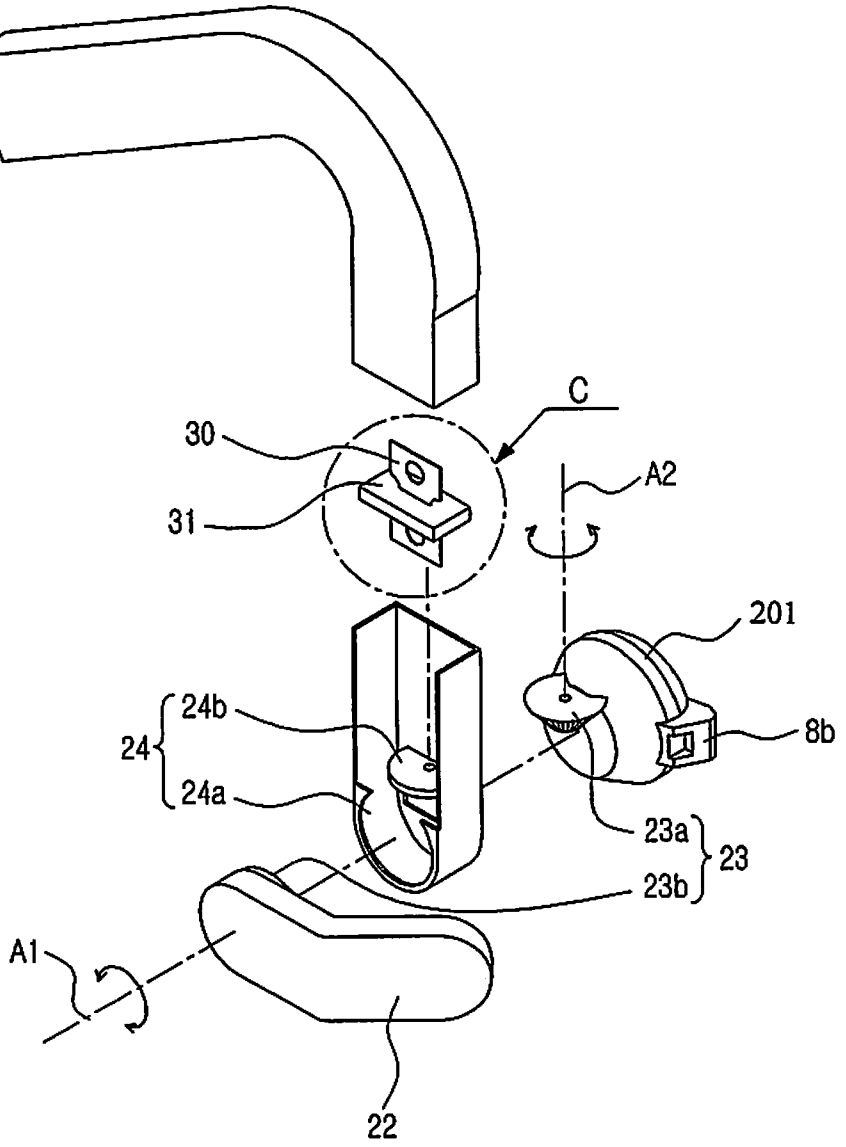

FIG.23

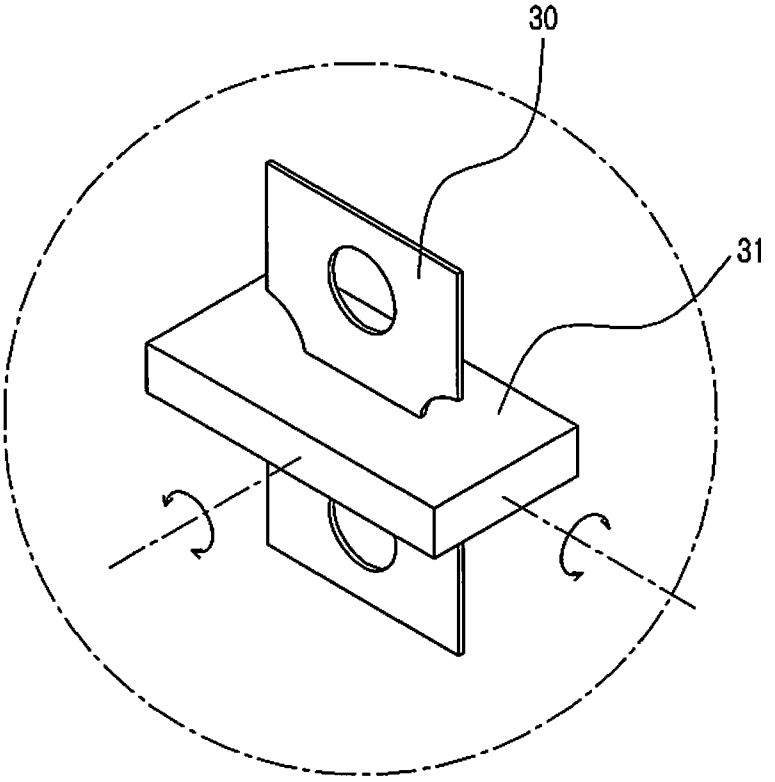

FIG.24

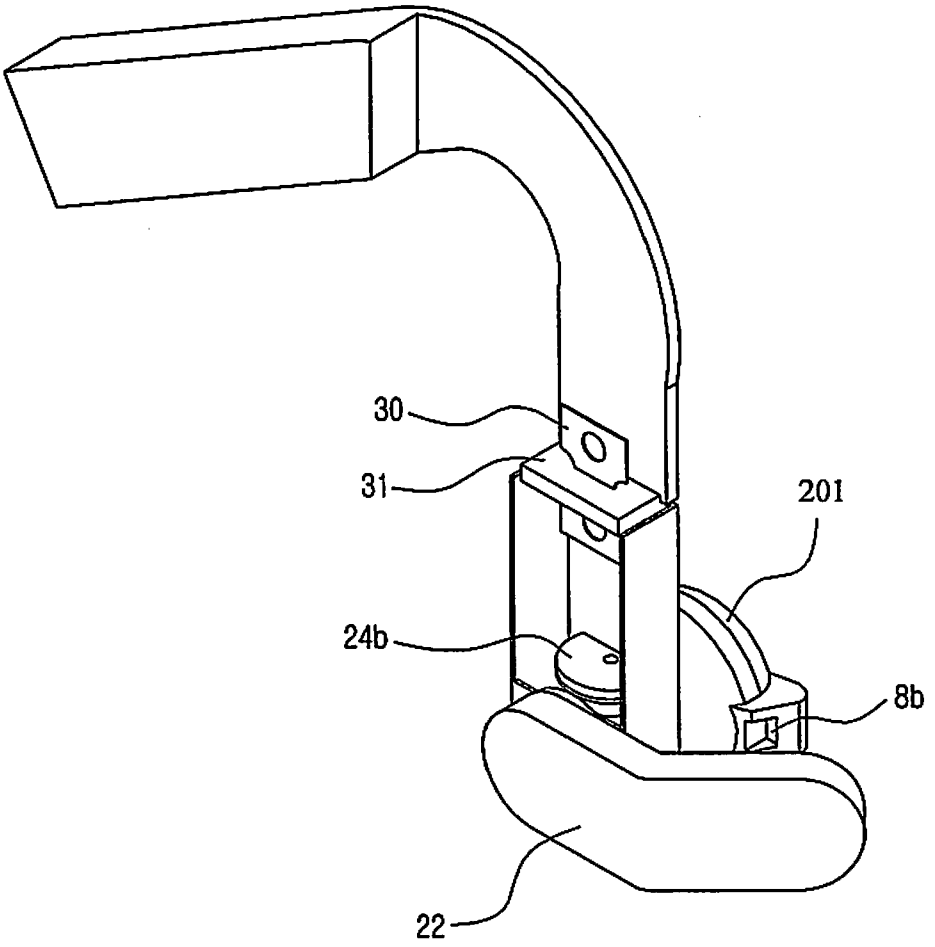

FIG.25

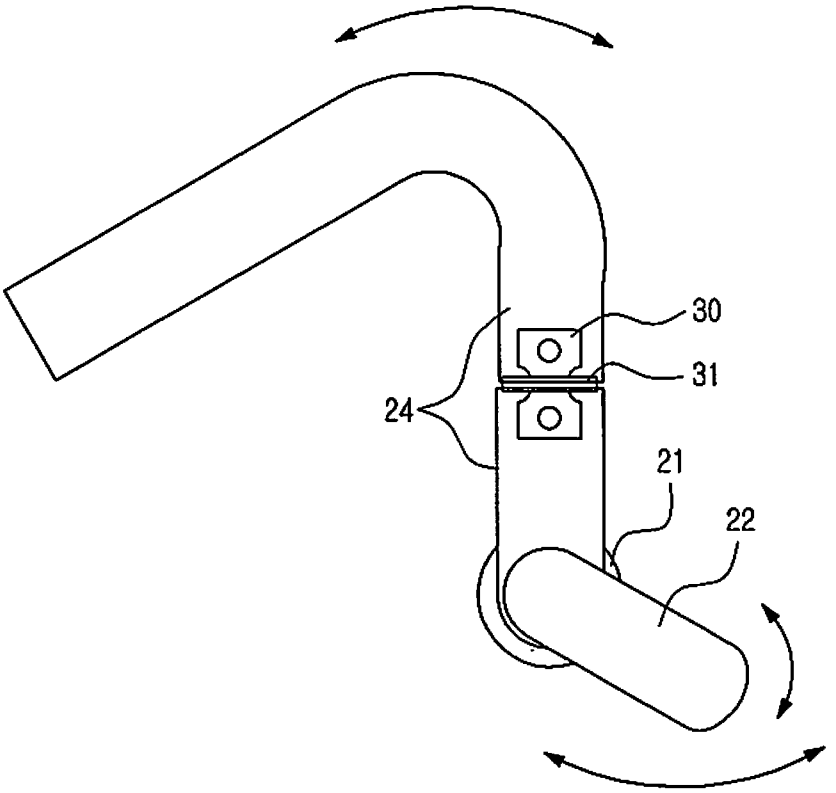

FIG.26

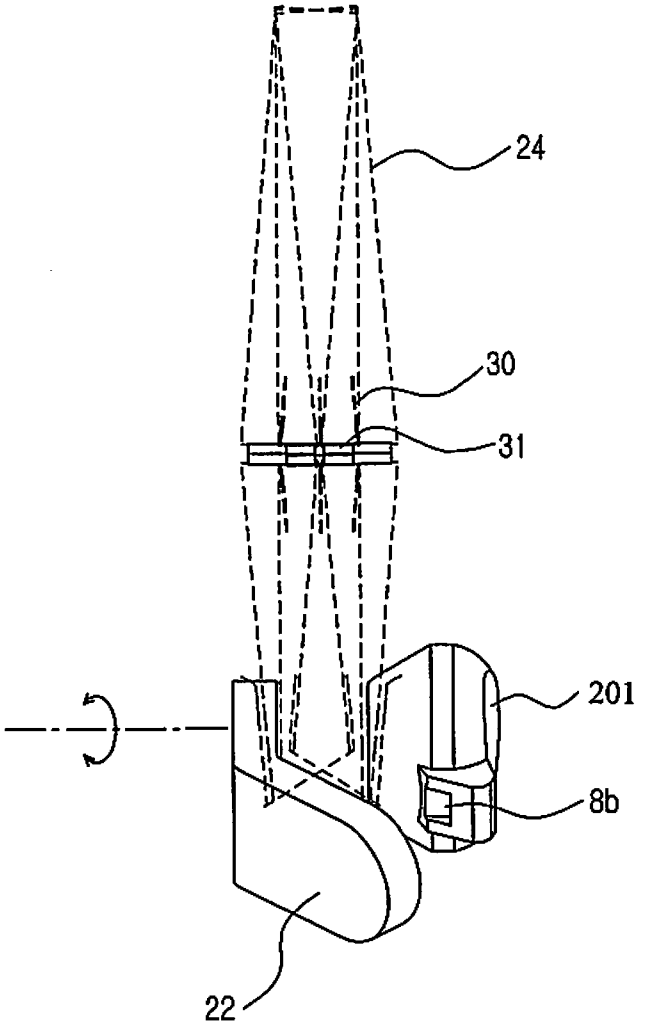

FIG.27

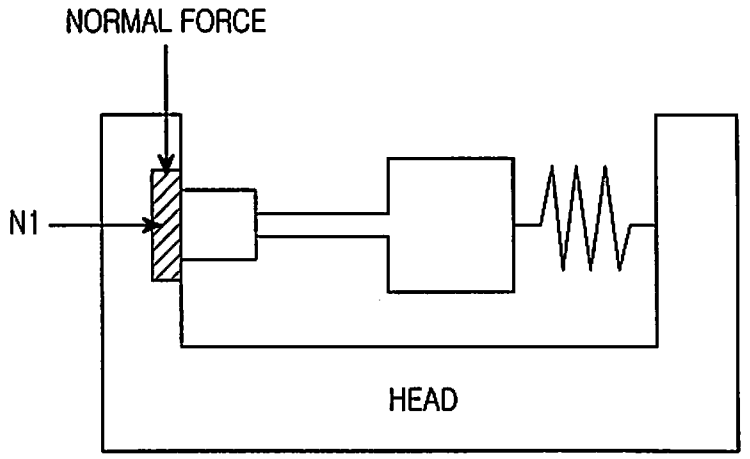

FIG.28A

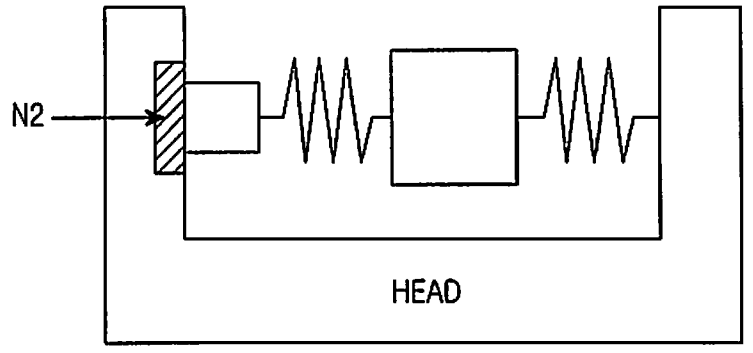

FIG.28B

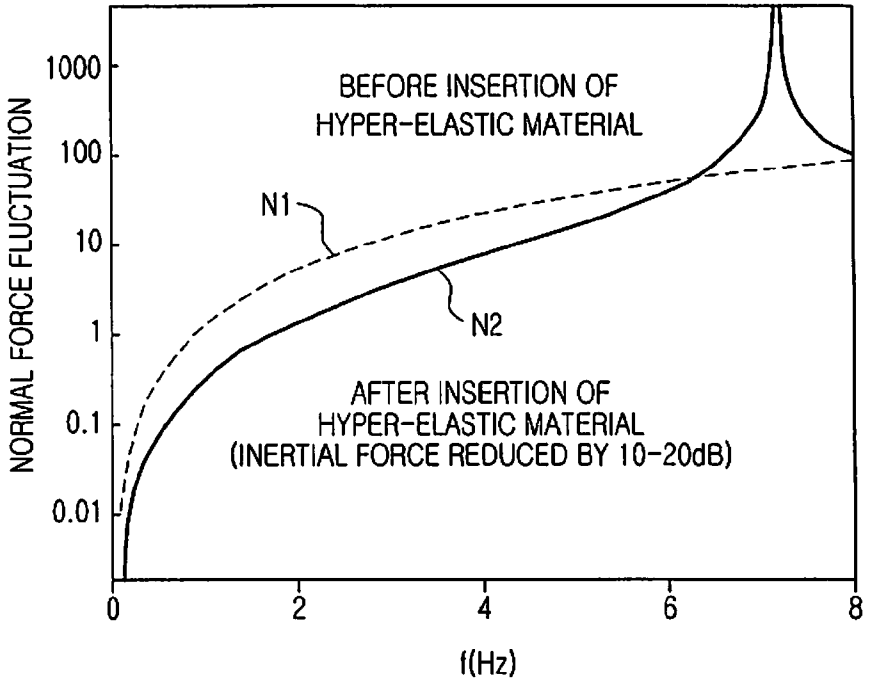

FIG.28C

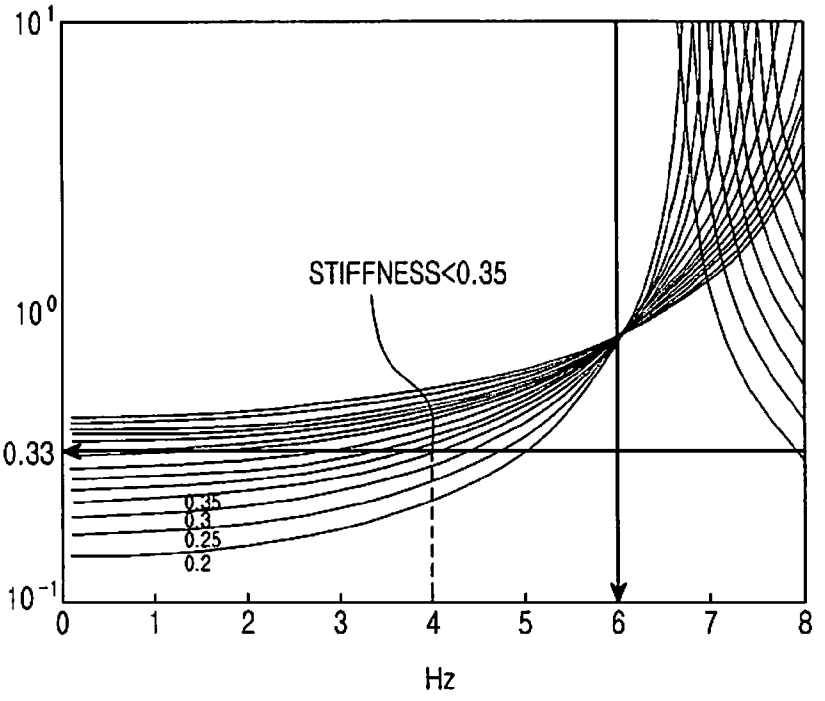

FIG.28D

EARPHONE DEVICE HAVING BIOLOGICAL INFORMATION MEASURING APPARATUS

PRIORITY

This application claims priority under 35 U.S.C. §119(a) to a Korean Patent Application filed in the Korean Intellectual Property Office on Oct. 7, 2009 and assigned Serial No. 10-2009-0095161, the entire disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an earphone device having a biological information (or living body information) measuring apparatus structured to facilitate insertion of an earphone into a user's ear and to absorb vibration generated by external artificial movement before and after insertion of the earphone.

2. Description of the Related Art

Generally, a biological information measuring apparatus measures biological information about the bloodstream of a human body, such as pulse, heart rate, and the like. Products embodying these devices have various shapes and sizes, and some of them have been miniaturized to be portable or integrally incorporated within other products.

For example, there is a device having a pulse sensor embedded in a wrist watch. As the user contacts the pulse sensor provided in the wrist watch with a finger tip, a pulse is optically detected by the pulse sensor and a pulse rate is displayed on a display unit of a main body of the wrist watch.

Such a conventional biological information measuring apparatus generally uses an electrocardiogram (ECG) sensor, which measures a pulse rate by detecting an ECG signal with a multi-polar electrode. Also introduced is an optical sensor which measures biological information by radiating light onto a skin surface of a human body using a light emitting diode (LED) and detecting light output from the skin surface by the action of scattering in the human body using a photo diode (PD).

As disclosed in International Publication No. WO 2005/034742, which is incorporated herein by reference, the conventional biological information measuring apparatus is structured such that a pulse measuring sensor, one of transmissive optical sensors, for a part of a human ear known as the tragus is in the shape of a nipper and thus presses the tragus. Like a general nipper, the pulse-measuring sensor also includes two arms, a pivot, and a spring.

Recently, research is being conducted to downsize biological information measuring apparatuses, and as part of this, a device for mounting the measuring apparatus using the biological structure of a user's ears has been developed.

A biological information measuring apparatus connected to an earphone may operate according to the following schemes: measuring biological information through the skin in a transmissive manner by binding the measuring apparatus in a lobe by means of an additional apparatus independently of the earphone; measuring biological information through the skin in a transmissive manner by binding the measuring apparatus in an auricle by means of an apparatus independent of the earphone; measuring biological information through the skin in a transmissive manner by binding the measuring apparatus in a tragus portion; and especially for a wireless earphone, measuring biological information in a contact portion between the wireless earphone and skin except for an ear portion in a refractive manner.

However, the foregoing conventional schemes may have some problems. That is, if a sensor unit is completely separated from an earphone structure, a user may need an additional wire-connected device and do the troublesome work of mounting the sensor unit after inserting the earphone into the ear.

To solve the above-described problems, the sensor unit may be integrated into the earphone. In this case, however, the user may feel discomfort during or after wearing the sensor unit and measurement may be totally impossible due to significant signal distortion caused by artificial movement generated during times when the user is moving, such as during exercise.

As such, when the biological information measuring apparatus is mounted in the earphone, it performs measurements on the user's auricle portion in the transmissive manner, whereby much noise may be generated by the movement of the earphone and the head portion. Generally there is no way to prevent the movement of the earphone and the head portion due to the existence of only an ear hook portion to secure the earphone to the user's ear.

As shown in FIG. **1**, a neckband type earphone **1** in a shape similar to a headphone where speakers are mounted on both ends of a neckband behind the head of a user has been developed in an effort to solve the foregoing problems.

The neckband type earphone **1** includes a neckband portion **2**, sub neckband portions **3** provided at both ends of the neckband portion **2**, and speaker portions **4** provided on the sub neckband portions **3**. The neckband portion **1** includes a battery unit **5**, a sensor controller **6**, and a radio frequency (RF) unit **7**.

The neckband type earphone **1** also includes a biological information measuring apparatus, which includes a sensor unit **8** having an LED **8***a* and a PD **8***b*.

However, as shown in FIG. **2**, the conventional neckband type earphone **1** is hung on a tragus portion **101** of a user's ear **100**, and thus the speaker portions **4** cannot be completely inserted.

To address this problem, a high-elasticity wire, which is easily deformed, is inserted into the sub-neckband portions of a conventional neckband type earphone, such that they are freely deformed during insertion of the earphone into a user's ear. However, when the user having worn the earphone strenuously exercises, for example, runs or walks, the wire is likely to be deformed by shock and vibration perpendicular to the user's moving direction. As a result, the earphone is separated from the user's ear and thus the biological information measuring apparatus cannot measure the user's biological information. Moreover, after the earphone is used for a long time, the sub-neckband portions are prone to damage.

To extract a biological signal, a sensor unit is generally positioned in a body contact portion, which may be a tragus, an entry to an internal auditory canal, or a temple, which contacts a speaker portion. However, near the temple, the user's hair and hair follicles as well as skin are present, resulting in a limitation in biological signal extraction using light.

If measurement is performed in the tragus, or through entry to the internal auditory canal of the user's ear, the earphone may not be easily inserted due to the size of the speaker portion having the sensor unit mounted thereon, in spite of removal of the influence of hair or the like.

Accordingly, there is a need for an apparatus which facilitates insertion of an earphone into a user's ear by using rotation, and delivers only a minimal part of a shock and vibration to the earphone, caused by strenuous movement after insertion of the earphone, by absorbing the shock and

vibration, thereby guaranteeing convenience in wearing a biological information measuring apparatus and improving the performance of the biological information measuring apparatus.

SUMMARY OF THE INVENTION

An aspect of the present invention is to address at least the above problems and/or disadvantages and to provide at least the advantages described herein. Accordingly, an aspect of the present invention is to provide an earphone device having a biological information measuring apparatus, which is structured with at least a shaft, a support housing, and a stopper portion to facilitate insertion of an earphone into a user's ear, thereby improving the comfort of a product and thus reducing discomfort after wearing the earphone, and preventing signal distortion from occurring due to vibrations generated during the user's strenuous exercise.

Moreover, another aspect of the present invention is to provide an earphone device having a biological information measuring apparatus, which is structured with at least a gear portion and a support housing to facilitate insertion of an earphone into a user's ear, thereby improving the comfort of a product and thus reducing discomfort while wearing the earphone, and preventing signal distortion from occurring due to vibrations generated during the user's strenuous exercise.

Furthermore, another aspect of the present invention is to provide an earphone device having a biological information measuring apparatus, which is structured with an elastic portion for reducing vibration by absorbing inertial forces generated by external movement after insertion of an earphone, and increasing or reducing stiffness in a direction affecting the comfort of a product, thereby preventing signal distortion from occurring due to vibrations generated during the user's strenuous exercise.

According to an aspect of the present invention, there is provided an earphone device including a biological information measuring apparatus, the earphone device including a speaker portion, a sensor housing rotatably coupled with the speaker portion, a shaft provided in the speaker portion and the sensor housing to couple the speaker portion with the sensor housing such that the speaker portion and the sensor housing rotate together, a support housing coupled with the shaft to pass the shaft therethrough, the support housing supporting rotation of the speaker portion and the sensor housing, and a stopper portion provided in the shaft and the support housing to rotate the speaker portion and the sensor housing and then stop them before or after insertion into a user's ear, thereby facilitating the insertion or urging the speaker portion to contact the user's ear.

According to another aspect of the present invention, there is provided an earphone device including a biological information measuring apparatus, the earphone device including a speaker portion, a sensor housing rotatably coupled with the speaker portion, a shaft provided in the speaker portion and the sensor housing to couple the speaker portion with the sensor housing such that the speaker portion and the sensor housing rotate together, a support housing coupled with the shaft to pass the shaft therethrough, the support housing supporting rotation of the speaker portion and the sensor housing, a stopper portion provided in the shaft and the support housing to rotate the speaker portion and the sensor housing and then stop them before or after insertion into a user's ear, thereby facilitating the insertion or urging the speaker portion to contact the user's ear, and an elastic portion provided in the support housing to absorb inertial forces generated by external movement.

According to another aspect of the present invention, there is provided an earphone device including a biological information measuring apparatus, the earphone device including a speaker portion, a sensor housing rotatably coupled with the speaker portion, a gear portion provided in the speaker portion and the sensor housing to rotate the sensor housing about a first rotation axis and the speaker portion about a second rotation axis, and a support housing for supporting the speaker portion and the sensor housing such that the speaker portion and the sensor housing rotate about the second rotation axis and the first rotation axis by means of the gear portion.

According to another aspect of the present invention, there is provided an earphone device including a biological information measuring apparatus, the earphone device including a speaker portion, a sensor housing rotatably coupled with the speaker portion, a gear portion provided in the speaker portion and the sensor housing to rotate the sensor housing about a first rotation axis and the speaker portion about a second rotation axis, a support housing for supporting the speaker portion and the sensor housing to allow the speaker portion and the sensor housing to rotate about the second rotation axis and the first rotation axis by means of the gear portion, and an elastic portion provided in the support housing to absorb inertial forces generated by external movement.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features and advantages of exemplary embodiments of the present invention will be more apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a perspective view of an earphone device having a biological information measuring apparatus according to the prior art;

FIG. **2** is a side cross-sectional view showing a state where the earphone device shown in FIG. **1** is used;

FIG. **3** is an exploded perspective view of an earphone device having a biological information measuring apparatus according to a first embodiment of the present invention;

FIG. **4** is another exploded view of the earphone device having the biological information measuring apparatus according to the first embodiment of the present invention;

FIG. **5** is a perspective view showing an assembled state of the earphone device having the biological information measuring apparatus according to the first embodiment of the present invention;

FIG. **6** is an enlarged perspective view of a portion A of FIG. **5**;

FIG. **7** is a perspective view showing a pre-operation (or before-operation) state of the earphone device having the biological information measuring apparatus according to the first embodiment of the present invention;

FIG. **8** is a plan view showing the pre-operation state of the earphone device having the biological information measuring apparatus according to the first embodiment of the present invention;

FIG. **9** is a perspective view showing a state where the earphone device having the biological information measuring apparatus according to the first embodiment of the present invention is worn on a user's ear;

FIG. **10** is a perspective view showing an in-operation state of the earphone device having the biological information measuring apparatus according to the first embodiment of the present invention;

FIG. **11** is a plan view showing the in-operation state of the earphone device having the biological information measuring apparatus according to the first embodiment of the present invention;

FIG. **12** is an exploded perspective view of an earphone device having a biological information measuring apparatus according to a second embodiment of the present invention;

FIG. **13** is an enlarged exploded perspective view of a portion B of FIG. **12**;

FIG. **14** is a perspective view showing an assembled state of the earphone device having the biological information measuring apparatus according to the second embodiment of the present invention;

FIG. **15** is a side view showing an in-operation state of the earphone device having the biological information measuring apparatus according to the second embodiment of the present invention;

FIG. **16** is a front view showing the in-operation state of the earphone device having the biological information measuring apparatus according to the second embodiment of the present invention;

FIG. **17** is an exploded perspective view showing an earphone device having a biological information measuring apparatus according to a third embodiment of the present invention;

FIG. **18** is another exploded perspective view showing the earphone device having the biological information measuring apparatus according to the third embodiment of the present invention;

FIG. **19** is a perspective view showing a partially assembled state of the earphone device having the biological information measuring apparatus according to the third embodiment of the present invention;

FIG. **20** is a perspective view showing a pre-operation (or before-operation) state of the earphone device having the biological information measuring apparatus according to the third embodiment of the present invention;

FIG. **21** is a plan view showing the pre-operation state of the earphone device having the biological information measuring apparatus according to the third embodiment of the present invention;

FIG. **22** is a side cross-sectional view showing a state where the earphone device having the biological information measuring apparatus according to the third embodiment of the present invention is worn on a user's ear;

FIG. **23** is an exploded perspective view of an earphone device having a biological information measuring apparatus according to a fourth embodiment of the present invention;

FIG. **24** is an enlarged exploded perspective view of a portion C of FIG. **23**;

FIG. **25** is a perspective view showing an assembled state of the earphone device having the biological information measuring apparatus according to the fourth embodiment of the present invention;

FIG. **26** is a side view showing an in-operation state of the earphone device having the biological information measuring apparatus according to the fourth embodiment of the present invention;

FIG. **27** is a front view showing the in-operation state of the earphone device having the biological information measuring apparatus according to the fourth embodiment of the present invention;

FIG. **28**A is a schematic view showing a state before an elastic portion in the earphone device according to the second embodiment of the present invention or the earphone device according to the fourth embodiment of the present invention is inserted into a support housing;

FIG. **28**B is a schematic view showing a state after the elastic portion is inserted into the support housing;

FIG. **28**C is a graph showing a normal force before and after the elastic portion is inserted into the support housing; and

FIG. **28**D is a graph showing a change in stiffness of the elastic portion.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE PRESENT INVENTION

Hereinafter, exemplary embodiments of the present invention will be described in detail with reference to the accompanying drawings. In the following description, detailed descriptions of known functions and configurations have been omitted for clarity and conciseness. Therefore, it should be apparent to those skilled in the art that various changes and modifications of the embodiments described herein can be made without departing from the scope and spirit of the invention.

As shown in FIGS. **3** through **11**, an earphone device **10** having a biological information measuring apparatus includes a speaker portion **11**, a sensor housing **12**, a shaft **13**, a support housing **14**, and a stopper portion **15**.

As shown in FIGS. **3** and **4**, the biological information measuring apparatus includes a sensor unit **8** which may be referred to as a photoplethysmography (PPG) measurement sensor or a transmissive type sensor used to acquire a pulse rate that serves as base data for measuring an exercise state and an exercise quantity, and measuring and releasing stress. The sensor unit **8** may include a light emitting diode (LED) **8***a* and a photodiode (PD) **8***b*. The speaker portion **11** is provided with the PD **8***b* to contact a side opposite to a tragus **101** of a user's ear **100**.

As shown in FIGS. **3** through **11**, the sensor housing **12** is provided with the LED **8***a* to contact the tragus **101** of the user's ear **100**, and is rotatably coupled with the speaker portion **11**. The shaft **13** is provided in the speaker portion **11** and the sensor housing **12** such that the speaker portion **11** and the sensor housing **12** are coupled to rotate together. The support housing **14** is through-coupled with the shaft **13** and is provided between the speaker portion **11** and the sensor housing **12** to support rotation of the speaker portion **11** and the sensor housing **12**. The stopper portion **15** is provided between the shaft **13** and the support housing **14**, so that the stopper portion **15** rotates the speaker portion **11** and the sensor housing **12** in a direction for facilitating insertion into the user's ear **100** and then stops the speaker portion **11** and the sensor housing **12**, and in this state, the speaker portion **11** is inserted into the user's ear **100**, after which the stopper portion **15** again rotates and then stops the speaker portion **11** to urge the speaker portion **11** to contact the user's ear **100**.

As shown in FIGS. **3** and **4**, the shaft **13** includes a first shaft **13***a* and a second shaft **13***b*. The first shaft **13***a* is formed in the speaker portion **11** to be coupled with the second shaft **13***b*, and the second shaft **13***b* is formed in the sensor housing **12** to be coupled with the first shaft **13***a* and to rotate the speaker portion **11** and the sensor housing **12** together.

As shown in FIGS. **3** and **4**, to couple the speaker portion **11** and the sensor housing **12** in a way to rotate them together, at least one or more of coupling protrusion **11***a* and groove **11***b* are formed in the first shaft **13***a* and at least one or more of

coupling protrusion **12***a* and groove **12***b* are formed in the second shaft **13***b*. In the support housing **14** is formed a rotation hole **14***a* to pass the first shaft **13***a* and the second shaft **13***b* therethrough and support rotation.

As shown in FIGS. **3** and **11**, the stopper portion **15** includes a guide pin **15***a*, a guide portion **15***b*, and at least one or more stopper engaging/disengaging portion **15***c*. The guide pin **15***a* is formed on the rotation hole **14***a* to be guided by the guide portion **15***b*. The guide portion **15***b* is formed in the first shaft **13***a* and second shaft **13***b* to be coupled with the guide pin **15***a* and to guide the guide pin **15***a* when the speaker portion **11** and the sensor housing **12** rotate together. The stopper engaging/disengaging portion **15***c* is provided in a rotation end position of the speaker portion **11** and the sensor housing **12**, and is formed in the guide portion **15***b* such that the stopper engaging/disengaging portion **15***c* is engaged with or disengaged from the guide pin **15***a* in the rotation end position of the speaker portion **11** and the sensor housing **12** to stop the speaker portion **11** and the sensor housing **12** after their rotation.

As shown in FIG. **6**, the guide portion **15***b* is a guide groove and the stopper engaging/disengaging portion **15***c* is a hemispheric protrusion.

With reference to FIGS. **3** through **11**, a detailed description will now be made of an operation of the earphone device having the biological information measuring apparatus according to the first embodiment of the present invention.

As shown in FIGS. **3** through **11**, the earphone device **10** having the biological information measuring apparatus includes the speaker portion **11** having the PD **8***b*, the sensor housing **12** having the LED **8***a*, the shaft **13**, the support housing **14**, and the stopper portion **15**.

In the speaker portion **11** is formed the first shaft **13***a* where at least one or more coupling protrusion **11***a* and groove **11***b* are formed. In the sensor housing **12** is formed the second shaft **13***b* where at least one or more coupling protrusions **12***a* and groove **12***b* are formed.

As shown in FIGS. **3** and **4**, the first shaft **13***a* of the speaker portion **11** and the second shaft **13***b* of the sensor housing **12** are coupled with each other while facing each other, and at the same time, the coupling protrusions **11***a* and **12***b* and grooves **11***b* and **12***b* formed in the first shaft **13***a* and the second shaft **13***b* are coupled with each other, respectively.

As the first shaft **13***a* and the second shaft **13***b* are coupled with each other, the speaker portion **11** and the sensor housing **12** can rotate together.

In this state, the guide portion **15***b* formed in the first shaft **13***a* and a second shaft **13***b* is coupled to the guide pin **15***a* formed in the rotation hole **14***a* of the support housing **14**, so that the guide portion **15***b* can guide the guide pin **15***a*.

As shown in FIGS. **5** and **6**, a user rotates the speaker portion **11** and the sensor housing **12** in a normal direction, which is a direction for facilitating insertion of the speaker portion **11** into the user's ear **100** before the insertion. As the speaker portion **11** and the sensor housing **12** rotate together, the guide portion **15***b* of the stopper portion **15** also rotates in the normal direction. The guide portion **15***b* guides the guide pin **15***a* along with its rotation in the normal direction. The guide portion **15***b* is stopped by the guide pin **15***a* in the rotation end position of the speaker portion **11** and the sensor housing **12**.

As shown in FIG. **8**, the guide pin **15***a* contacts and is inserted into the stopper engaging/disengaging portion **15***c* formed in the rotation end position of the guide portion **15***b*, thus stopping the rotation of the guide portion **15***b*.

The guide portion **15***b* and the stopper engaging/disengaging portion **15***c* rotate the speaker portion **11** and the sensor housing **12** together in the normal direction and then stop the speaker portion **11** and the sensor housing **12**.

In this state, as shown in FIG. **7**, the speaker portion **11** can be easily inserted into the user's ear **100**. At this point, the PD **8***b* of the speaker portion **11** is positioned between intertragic notches of the ear of the user such that the speaker portion **11** is inserted into the ear **100** without being obstructed by the tragus **101** of the ear.

In this condition, as shown in FIGS. **9** through **11**, after inserting the speaker portion **11**, the user rotates the sensor housing **12** in a reverse direction, such that the sensor housing **12** and the speaker portion **11** rotate together in the reverse direction and the guide portion **15***b* also rotates.

At this point, as shown in FIG. **11**, the guide pin **15***a* leaves the stopper engaging/disengaging portion **15***c* and is guided along the rotating guide portion **15***b*, and then stops by being inserted into another guide engaging/disengaging portion **15***c* formed in the rotation end position of the speaker portion **11** and the sensor housing **12**.

As shown in FIG. **11**, the guide portion **15***b* and the stopper engaging/disengaging portion **15***c* rotate the speaker portion **11** and the sensor housing **12** in the reverse direction and then stop the speaker portion **11** and the sensor housing **12**.

At this time, as shown in FIG. **9**, the sensor housing **12** contacts the tragus **101** of the ear and the LED **8***a* of the sensor housing **12** and the PD **8***b* of the speaker portion **11** face each other with the tragus **101** therebetween. In this state, the sensor unit **8** can measure the user's biological information.

With reference to FIGS. **12** through **16**, a detailed description will now be made of an operation of an earphone device having the biological information measuring apparatus according to a second embodiment of the present invention.

As shown in FIGS. **12** through **16**, the earphone device **10** having the biological information measuring apparatus includes the speaker portion **11** having the PD **8***b*, the sensor housing **12** having the LED **8***a*, the shaft **13**, the support housing **14**, the stopper portion **15**, and an elastic portion **20**.

In the speaker portion **11** is formed the first shaft **13***a* where at least one or more of coupling protrusion **11***a* and groove **11***b* are formed. In the sensor housing **12** is formed the second shaft **13***b* where at least one or more of coupling protrusion **12***a* and groove **12***b* are formed.

The first shaft **13***a* of the speaker portion **11** and the second shaft **13***b* of the sensor housing **12** are coupled with each other while facing each other, and at the same time, the coupling protrusions **11***a* and **12***a* and grooves **11***b* and **12***b* formed in the first shaft **13***a* and the second shaft **13***b* are also coupled with each other, respectively.

As the first shaft **13***a* and the second shaft **13***b* are coupled with each other, the speaker portion **11** and the sensor housing **12** can rotate together.

In this state, the guide portion **15***b* formed in the first shaft **13***a* and the second shaft **13***b* is coupled to the guide pin **15***a* formed in the rotation hole **14***a* of the support housing **14**, so that the guide portion **15***b* can guide the guide pin **15***a*.

As shown in FIGS. **12** and **13**, the elastic portion **20** is provided in the support housing **14** to absorb a force, such as inertial forces generated by external movement (for example, a user's strenuous exercise).

As shown in FIGS. **14** through **16**, the elastic portion **20** reduces stiffness in a direction that inertial forces are delivered and increases stiffness in other directions that inertial force is not delivered. As such, the elastic portion **20** increases elasticity in a direction that large inertial forces are generated, and decreases elasticity in a direction that small inertial forces are generated. The elastic portion **20** may be composed of an

elastic material, such as a metal elastic material or a leaf spring, as well as a hyper-elastic material.

As shown in FIG. **14**, in the middle of the elastic portion **20** is provided a support member **21** for supporting the elastic portion **20** in a way to allow the elastic portion **20** to absorb inertial forces generated by external movement.

As shown in FIGS. **3** through **6**, the user rotates the speaker portion **11** and the sensor housing **12** in the normal direction, which is a direction for facilitating insertion of the speaker portion **11** into the user's ear **100** before the insertion.

In this moment, the speaker portion **11** and the sensor housing **12** rotate together and the guide portion **15***b* of the stopper portion **15** also rotates in the normal direction.

The guide portion **15***b* guides the guide pin **15***a* along with its rotation in the normal direction.

The guide portion **15***b* is stopped by the guide pin **15***a* in the rotation end position of the speaker portion **11** and the sensor housing **12**.

The guide pin **15***a* contacts and is inserted into the stopper engaging/disengaging portion **15***c* formed in the rotation end position of the guide portion **15***b*, thus stopping the rotation of the guide portion **15***b*.

The guide portion **15***b* and the stopper engaging/disengaging portion **15***c* rotate the speaker portion **11** and the sensor housing **12** together in the normal direction and then stop the speaker portion **11** and the sensor housing **12**.

In this state, the speaker portion **11** can be easily inserted into the user's ear **100**.

The PD **8***b* of the speaker portion **11** is positioned between intertragic notches of the user such that the speaker portion **11** is inserted into the ear **100** without being obstructed by the tragus **101** of the ear.

In this condition, as shown in FIGS. **7** and **11**, after inserting the speaker portion **11**, the user rotates the sensor housing **12** in a reverse direction, such that the sensor housing **12** and the speaker portion **11** rotate together in the reverse direction and the guide portion **15***b* also rotates.

At this point, the guide pin **15***a* leaves the stopper engaging/disengaging portion **15***c* and is guided along the rotating guide portion **15***b*, and then stops by being inserted into another stopper engaging/disengaging portion **15***c* formed in the rotation end position of the speaker portion **11** and the sensor housing **12**.

The guide portion **15***b* and the stopper engaging/disengaging portion **15***c* rotate the speaker portion **11** and the sensor housing **12** in the normal direction and then stop the speaker portion **11** and the sensor housing **12**.

The sensor housing **12** contacts the tragus **101** of the user's ear **100**, and the LED **8***a* of the sensor housing **12** and the PD **8***b* of the speaker portion **11** face each other with the tragus **101** therebetween. In this state, the sensor unit **8** can measure biological information of the user.

As such, as shown in FIG. **7**, when external movement, i.e., running or walking, occurs by the user who is wearing the earphone device **10** on the ear, a normal force applied to the sensor unit **8** perpendicular to the user's moving direction is expressed by a product of a square of a movement frequency and a mass of the earphone device **10**.

As shown in FIGS. **15** and **16**, the elastic portion **20** reduces inertial forces generated by the external artificial movement and reduces vibration force, by absorbing the inertial forces.

FIGS. **28**A through **28**D show states before and after the elastic portion **20** is inserted into the support housing **14**. As can be seen in FIG. **28**C, a normal, or perpendicular, force after the insertion of the elastic portion **20** is ⅓ times less than a normal force before the insertion of the elastic portion **20**, and a main frequency of external movement such as strenuous movement, e.g., running is less than 4 Hz. Based on the foregoing results, the stiffness of the elastic portion **20** which causes a resonance frequency to be higher than 4 Hz can be estimated.

Shown in FIG. **28**D is a state of normal force for each frequency with respect to a partial stiffness. A partial stiffness by the elastic portion **20**, which satisfies two avoidance conditions (including the normal force avoidance condition and the resonance frequency avoidance condition) has to be smaller than 0.35 times the opening stiffness of the support housing **14**.

If the elastic portion **20** is constructed of a general elastic material, for example, a wire spring, it is not easy to reduce stiffness only perpendicular to the user's moving direction. In other words, the elastic force easily increases also in the user's moving direction, making it impossible to support the support housing **14**. As a result, during insertion of the speaker portion **11**, the elastic portion **20** moves down too much to enable the speaker portion **11** to be inserted.

To solve this problem, the elastic portion **20** is constructed of a hyper-elastic material.

The hyper-elastic material is preferably a nitinol material, which is transformed according to a transformation temperature at a transformation rate greater than a yield strength. The hyper-elastic nitinol material is applied with a constant force, and may be transformed at a transformation rate of up to about 8%, unlike a general elastic material.

As shown in FIGS. **15** and **16**, the hyper-elastic material portion **20** is in an 'I' shape and is coupled with an elastic material such as urethane. The hyper-elastic material portion **20** has different cross-sections, that is, a cross-section in a perpendicular direction to the moving direction is different from a cross-section in the moving direction. As a result, when a load generated by opening is applied to a thin and wide cross-section like a spring-board, a pressure applied to the section easily exceeds a hyper-elastic threshold pressure and works in a hyper-elastic region.

As such, the hyper-elastic material portion **20** reduces stiffness in a direction that the inertial force is delivered, and increases stiffness in other directions that the inertial force is not delivered, thereby improving wearing comfort by reducing stiffness in a direction affecting the wearing comfort, while minimizing the inertial forces generated by external movement.

With reference to FIGS. **17** through **22**, a detailed description will now be made of an operation of an earphone device having the biological information measuring apparatus according to a third embodiment of the present invention.

As shown in FIGS. **17** through **22**, an earphone device **200** having the biological information measuring apparatus includes a speaker portion **201**, a sensor housing **22**, a gear portion **23**, and a support housing **24**.

As shown in FIG. **22**, the speaker portion **201** includes the PD **8***b* to contact a side opposite to the tragus **101**. The sensor housing **22** includes the LED **8***a* to contact the tragus **101** and is rotatably coupled with the speaker portion **201**.

As shown in FIGS. **17** through **19**, the gear portion **23** is provided in the speaker portion **201** and the sensor housing **22** to rotate the sensor housing **22** about a first rotation axis A**1** and rotate the speaker portion **201** about a second rotation axis A**2**. The support housing **24** supports the speaker portion **201** and the sensor housing **22** to allow the sensor housing **22** and the speaker portion **201** to rotate by means of the gear portion **23** about the first rotation axis A**1** and the second rotation axis A**2**, respectively.

As shown in FIGS. **20** and **21**, the gear portion **23** may be a bevel gear or a spur gear, or may be a gear other than the bevel gear or the spur gear.

In the support housing **24** is formed a first support portion **24***a* which supports the sensor housing **22** in a way to allow rotation of the sensor housing **22** about the first rotation axis A**1**. In the support housing **24** is also formed a second support portion **24***b* which is coupled with and supports a speaker-side gear portion **23***a* formed on the speaker portion **201** in a way to allow rotation of the speaker portion **201** about the second rotation axis A**2**.

In this state, as shown in FIG. **20**, when the user first rotates the sensor housing **22** about the first axis A**1** in a normal direction which is a direction for facilitating insertion of the speaker portion **201** into the user's ear **100** prior to the insertion, the sensor housing **22** and a housing-side gear portion **23***b* formed in the sensor housing **22** also rotate together about the first rotation axis A**1** and the speaker-side gear portion **23***a* engaged with the housing-side gear portion **23***b* also rotates about the second rotation axis A**2** in the normal direction. As the speaker-side gear portion **23***a* rotates about the second rotation axis A**2**, the speaker portion **201** also rotates. The sensor housing **22** rotates about the first rotation axis A**1** toward a lower portion of the support housing **24**, and the speaker portion **201** rotates about the second rotation axis A**2** outwardly from the support housing **24**. In this state, the speaker portion **201** can be easily inserted into the user's ear **100**.

In this condition, the PD **8***b* of the speaker portion **201** is positioned between intertragic notches of the user's ear such that the speaker portion **201** is inserted into the ear **100** without being obstructed by the tragus **101** of the ear.

At this point, as shown in FIGS. **21** and **22**, after inserting the speaker portion **201**, the user rotates the sensor housing **22** about the first rotation axis A**1** in a reverse direction and in this state, the speaker portion **201** rotates about the second rotation axis A**2** in the reverse direction.

As such, the sensor housing **22** rotates about the first rotation axis A**1** in the reverse direction toward an upper portion of the support housing **24** and the speaker portion **201** rotates about the second rotation axis A**2** in the reverse direction inwardly from the support housing **24**.

The LED **8***a* of the sensor housing **22** and the PD **8***b* of the speaker portion **201** come close to each other, contact the tragus **101**, and face each other with the tragus **101** therebetween. In this state, the sensor unit **8** can measure biological information of the user.

With reference to FIGS. **23** through **27**, a detailed description will now be made of an operation of an earphone device having a biological information measuring apparatus according to a fourth embodiment of the present invention.

As shown in FIGS. **23** and **24**, an elastic portion **30** may be provided to reduce inertial forces generated by external movements and reduces vibration force, by absorbing the inertial forces.

As described above, FIGS. **28**A through **28**C show states before and after the elastic portion **30** is inserted into the support housing **24**. As can be seen, a normal, or perpendicular, force after the insertion of the elastic portion **30** is ⅓ times less than a normal force before the insertion of the elastic portion **30**, and a main frequency of external artificial movement such as strenuous movement, e.g., running is less than 4 Hz. Based on the foregoing results, the stiffness of the elastic portion **30**, which causes a resonance frequency to be higher than 4 Hz can be estimated.

Shown in FIG. **28**D is a state normal force for each frequency with respect to a partial stiffness. A partial stiffness by the elastic portion **30**, which satisfies two avoidance conditions including the normal force avoidance condition and the resonance frequency avoidance condition, has to be smaller than 0.35 times the opening stiffness of the support housing **24**.

As also described above, if the elastic portion **30** is composed of a general elastic material, for example, a wire spring, it is not easy to reduce stiffness only perpendicular to the user's moving direction. In other words, the elastic force easily increases also in the user's moving direction, making it impossible to support the support housing **24**. As a result, during insertion of the speaker portion **201**, the elastic portion **30** moves down too much to enable the speaker portion **201** to be inserted.

To solve this problem, the elastic portion **30** is constructed of a hyper-elastic material, such as nitinol.

As shown in FIGS. **26** and **27**, the hyper-elastic material **30** in an 'I' shape and is coupled with an elastic material such as urethane. The hyper-elastic material **30** has different cross-sections, that is, a cross-section in a perpendicular direction to the moving direction is different from a cross-section in the moving direction. As a result, when a load generated by opening is applied to a thin and wide cross-section like a spring-board, a pressure applied to the section easily exceeds a hyper-elastic threshold pressure and works in a hyper-elastic region.

As shown in FIG. **27**, the elastic portion **30** reduces stiffness in a direction that the inertial force is delivered, and increases stiffness in other directions that the inertial force is not delivered, thereby improving wearing comfort by reducing stiffness in a direction affecting the wearing comfort, while minimizing the inertial force generated by external movement.

An earphone device having a biological information measuring apparatus according to the embodiments of the present invention has been illustrated as a representative example. However, an earphone device having a biological information measuring apparatus according to the present invention is not limited to the earphone device, and may be applied to any small-size electronic device (not shown) such as an information communication apparatus and a multimedia apparatus, which can contact a user's body.

It would be obvious to those of ordinary skill in the art that the above-described earphone device having the biological information measuring apparatus according to the present invention is not limited to the foregoing embodiments and drawings, and various substitutions, modifications, and changes may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. An earphone device having a biological information measuring apparatus, the earphone device comprising:

a speaker portion;

a sensor housing rotatably coupled with the speaker portion;

a shaft provided in the speaker portion and the sensor housing to couple the speaker portion with the sensor housing, wherein the shaft comprises a first shaft formed in the speaker portion and a second shaft formed in the sensor housing configured to be coupled with the first shaft to enable the speaker portion and the sensor housing to rotate together;

a support housing coupled with the shaft to pass the shaft therethrough, the support housing supporting the speaker portion and the sensor housing during rotation; and

a stopper portion provided in the shaft and the support housing to permit rotation of the speaker portion and the sensor housing and then to stop the rotation, thereby facilitating insertion into a user's ear and urging the speaker portion to contact the user's ear.

2. The earphone device of claim **1**, wherein at least one or more coupling protrusions and grooves are formed in the first shaft and the second shaft to couple the speaker portion with the sensor housing to enable the speaker portion and the sensor housing to rotate together.

3. The earphone device of claim **1**, wherein a rotation hole is formed in the support housing to pass the shaft therethrough and to support rotation.

4. The earphone device of claim **3**, wherein the stopper portion comprises:

a guide pin formed in the rotation hole;

a guide portion formed in the shaft and coupled with the guide pin to guide the guide pin during rotation of the speaker portion and the sensor housing; and

at least one or more stopper engaging/disengaging portions formed in the guide portion, provided in a rotation end position of the speaker and the sensor housing, and engaged with or disengaged from the guide pin in the rotation end position of the speaker portion and the sensor housing to stop the speaker portion and the sensor housing after rotation of the speaker portion and the sensor housing.

5. The earphone device of claim **3**, wherein the stopper portion permits rotation of the speaker portion and the sensor housing in a direction for facilitating insertion into the user's ear and then stops the rotation of the speaker portion and the sensor housing before the insertion, and permits rotation of the speaker portion and the sensor housing in a reverse direction and then stops the rotation of the speaker portion and the sensor housing after the insertion, thereby urging the speaker portion to contact the user's ear.

6. An earphone device having a biological information measuring apparatus, the earphone device comprising:

a speaker portion;

a sensor housing rotatably coupled with the speaker portion;

a shaft provided in the speaker portion and the sensor housing to couple the speaker portion with the sensor housing, wherein the shaft comprises a first shaft formed in the speaker portion and a second shaft formed in the sensor housing configured to be coupled with the first shaft to enable the speaker portion and the sensor housing to rotate together;

a support housing coupled with the shaft to pass the shaft therethrough, the support housing supporting the speaker portion and the sensor housing during rotation;

a stopper portion provided in the shaft and the support housing to permit rotation of the speaker portion and the sensor housing and then to stop the rotation, thereby facilitating insertion into a user's ear and urging the speaker portion to contact the user's ear; and

an elastic portion provided in the support housing to absorb inertial forces generated by external movement.

7. The earphone device of claim **6**, wherein the elastic portion reduces stiffness in a direction that the inertial force is delivered, and increases stiffness in other directions that the inertial force is not delivered.

8. The earphone device of claim **6**, wherein the elastic portion comprises a hyper-elastic material, which includes a support member for supporting the elastic portion to allow the elastic portion to absorb the inertial force.

9. The earphone device of claim **8**, wherein the elastic portion is in an 'I' shape.

10. An earphone device having a biological information measuring apparatus, the earphone device comprising:

a speaker portion;

a sensor housing rotatably coupled with the speaker portion;

a gear portion provided in the speaker portion and the sensor housing to enable rotation of the sensor housing about a first rotation axis and the speaker portion about a second rotation axis; and

a support housing for supporting the speaker portion and the sensor housing to enable the speaker portion and the sensor housing to rotate about the second rotation axis and the first rotation axis by means of the gear portion,

wherein the gear portion is configured to enable the speaker portion and the sensor housing to rotate together.

11. The earphone device of claim **10**, wherein the gear portion comprises one of a bevel gear or a spur gear.

12. The earphone device of claim **10**, wherein a first support portion is formed in the support housing and supports the sensor housing to allow the sensor housing to rotate about the first rotation axis, and

wherein a second support portion is formed in the support housing and is coupled with and supports a speaker-side gear portion formed on the speaker portion to allow the speaker portion to rotate about the second rotation axis.

13. An earphone device having a biological information measuring apparatus, the earphone device comprising:

a speaker portion;

a sensor housing rotatably coupled with the speaker portion;

a gear portion provided in the speaker portion and the sensor housing to enable rotation of the sensor housing about a first rotation axis and the speaker portion about a second rotation axis;

a support housing for supporting the speaker portion and the sensor housing to allow the speaker portion and the sensor housing to rotate about the second rotation axis and the first rotation axis by means of the gear portion; and

an elastic portion provided in the support housing to absorb inertial forces generated by external movement,

wherein the gear portion is configured to enable the speaker portion and the sensor housing to rotate together.

14. The earphone device of claim **13**, wherein the elastic portion reduces stiffness in a direction that the inertial force is delivered, and increases stiffness in other directions that the inertial force is not delivered.

15. The earphone device of claim **13**, wherein the elastic portion comprises a hyper-elastic material, which includes a support member for supporting the elastic portion to allow the elastic portion to absorb the inertial force.

16. The earphone device of claim **15**, wherein the elastic portion is in an 'I' shape.

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